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Ana Jorge Romão São Marcos

Medição de Atividade Física em adolescentes

Physical activity measurements in adolescents

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Physical activity measurements in adolescents:
Accelerometry vs PAI

Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Fisioterapia, realizada sob a orientação científica da Doutora Alda Marques, Professora Adjunta da Escola Superior de Saúde da Universidade de Aveiro.

O Júri

Presidente

Prof. Doutor Rui Jorge Dias Costa

professor adjunto da Escola Superior de Saúde da Universidade de Aveiro

Arguente

Prof. Doutor João Paulo Venâncio

professor adjunto do Instituto Politécnico de Saúde do Norte - Escola Superior de Saúde do Vale do Sousa

Orientador

Prof. Doutora Alda Sofia Pires de Dias Marques

professora adjunta da Escola Superior de Saúde da Universidade de Aveiro

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Palavras-chave Atividade física, acelerometria, adolescentes

Sumário

Enquadramento: A prática de atividade física (AF) tem vindo a apresentar benefícios para a saúde em todas as idades, nomeadamente na pediatria. Existem vários métodos para avaliar a AF, no entanto os mais utilizados são os questionários e a acelerometria. Esta última é uma medida objetiva que, no entanto, requer o uso de instrumentos relativamente dispendiosos. Já os questionários são instrumentos rápidos e fáceis de aplicar, sendo, assim úteis na avaliação da AF. Apesar de existirem alguns instrumentos para avaliar AF em adolescentes, ainda, não existe nenhum validado contra a acelerometria para a população portuguesa. Esta validação é necessária, uma vez que os questionários, por serem medidas subjetivas apresentam um erro associado a imprecisões na capacidade de relato de atividades passadas.

Objetivos: Validar o Índice de Atividade Física (IAF) comparando-o com a acelerometria de acordo com o género e explorar se os adolescentes seguem as recomendações de AF estabelecidas para as suas idades.

Métodos: Neste estudo transversal, os adolescentes foram recrutados de 3 equipas de basquetebol, 2 turmas de uma escola de Aveiro e 1 turma de uma banda de música de orquestra. Dados sociodemográficos, antropométricos e de espirometria foram recolhidos aos participantes. AF foi medida com acelerómetros (Actigraph modelo - GT3XPlus, Actigraph MTI, Manufacturing Technology Inc., Pensacola, FL, USA), usados durante 7 dias e com o IAF. O coeficiente de correlação de Pearson (rs) foi calculado para explorar as correlações entre os minutos de AF moderada a vigorosa (AFMV) (min.dia^{-1}) e os passos por dia vs. o IAF. Para analisar a capacidade dos participantes seguirem as recomendações dos níveis de AF, foram considerados 60 minutos.dia^{-1} de AFMV e os 10,000 a 11,700 passos por dia. Testes Qui-quadrado (χ^2) foram usados para explorar diferenças na capacidade de atingir os níveis de AF estabelecidos em orientações internacionais entre rapazes e raparigas.

Resultados: Quarenta e nove adolescentes (57.14% raparigas; idade média 14.43 ±0.96 anos) participaram no estudo. Raparigas e rapazes apresentaram níveis de AF semelhantes, medidos com medidas subjetivas ou objetivas. As correlações entre as medidas subjetiva e objetiva foram significativas e positivas apenas para os rapazes (AFMV: r=.514, p=.017; Passos por dia: r=.460, p=.041). A maioria dos adolescentes mostraram-se sedentários na análise dos dados objetivos e das recomendações de AF. Apenas 1 rapariga (3.57%) e 3 rapazes (14.29%) ultrapassaram a marca dos 60 minutos.dia^{-1} de AFMV e em relação aos passos por dia, apenas 13 raparigas (46.43%) e 13 rapazes (61.90%) registaram valores acima dos 10,000 passos por dia.

Conclusão: O IAF mostrou-se uma ferramenta válida na medição de AF em comparação com a acelerometria, apenas para os rapazes. Adolescentes de ambos os sexos apresentaram níveis de AF semelhantes, em ambos os instrumentos de medida, tendo-se a maioria revelado como sedentários através da análise dos resultados obtidos pela acelerometria Desta forma, é necessário investigar-se mais, no futuro, sobre a correlação entre a acelerometria e o IAF, bem como sobre os hábitos sedentários dos adolescentes.

Keywords

Physical activity, accelerometry, adolescents

Abstract

Background: Practicing physical activity (PA) has shown to present health benefits at all ages, namely in paediatrics. There are several methods to evaluate PA, however the most frequently used are the self-report questionnaires and accelerometry. The latter is an objective measuring tool, however it requires the use of relatively expensive devices. Questionnaires are easy and quick to apply, and therefore a useful tool to evaluate PA. Despite the existence of some questionnaires to evaluate PA in adolescents, there is still none validated against accelerometry for the Portuguese population. This validation is important, since questionnaires present an error associated to inaccuracies in recall activity.

Aims: To validate the Physical Activity Index (PAI), by comparing it with accelerometry in adolescents according to gender and to explore if adolescents follow the physical activity recommendations established for their age.

Methods: In this cross-sectional study, adolescents were recruited from 3 basketball teams, 2 classrooms from a school in Aveiro, and an orchestra band classroom. Socio-demographic, anthropometric data and spirometry were collected from the adolescents who participated in this study. Physical Activity (PA) was assessed with accelerometers (Actigraph model - GT3XPlus, Actigraph MTI, Manufacturing Technology Inc., Pensacola, FL, USA) worn during 7 days and the PAI. Pearson correlation coefficients (rs) were calculated to explore the correlations of moderate-to-vigorous PA (MVPA) ($min.day^{-1}$) and steps per day vs. the PAI. To analyse participants' ability to follow the recommendations of PA levels, 60 minutes of MVPA and 10,000 to 11,700 steps per day were considered. Chi-square (χ^2) tests were used to explore differences between male and female's ability to reach international recommendations of physical activity levels.

Results: Forty nine adolescents (57.14% female; mean age 14.43 ±0.96 years old) participated in this study. Female and male presented similar PA levels measured with a subjective or an objective measure. Correlations between objective and subjective measures were significant and positive only for male (MVPA: r=.514, p=.017; Steps per day: r=.460, p=.041). Most participants were sedentary when analysing the objective data and considering the PA recommendations. Only 1 female (3.57%) and 3 males (14.29%) surpassed the 60 $min.day^{-1}$ mark and, in terms of steps per day, only 13 females (46.43%) and 13 males (61.90%) registered over 10000 steps per day.

Conclusion: When compared with accelerometry the PAI presented as a valid measuring tool only for male adolescents. Adolescents of both genders presented similar levels of PA with both measuring tools, and accelerometry results showed that the majority of adolescents were sedentary. Thus, it is necessary to investigate further in the future about the correlation between accelerometry and the PAI, as well as about the sedentary habits of adolescents.

Abreviaturas e/ou siglas

PA – Physical activity

MVPA – Moderate to Vigorous Physical Activity

DLW – Doubly Labeled Water

IPAQ - International Physical Activity Questionnaire

WHO - World Health Organization

PAI – Physical Activity Index

BMI – Body Mass Index

ICC - Intraclass correlation coefficient

FEV1– Forced Expiratory Volume in 1 second

FVC – Forced Vital Capacity

FEV1/FVC – Ratio between Forced Expiratory Volume in 1 second and Forced Vital Capacity

ATS/ERS - American Thoracic Society/European Respiratory Society

rs – Pearson correlation coefficient

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BACKGROUND

It is widely accepted that physical activity (PA) is important for promoting health and preventing diseases (e.g., cardiovascular disease, diabetes mellitus type II, obesity) in the adult population, especially if performed regularly (Hagstromer et al., 2008; Plasqui & Westerterp, 2007). Among school-aged adolescents, a physically active lifestyle can contribute to health benefits both in their present and future life (De Meester, De Bourdeaudhuij, Deforche, Ottevaere, & Cardon, 2011). Telama et al. (2005) concluded that a high level of PA between the age of 9 and the age of 18, especially when continuous, significantly predicted a high level of adult PA. Although the correlations were low to moderate, school-age PA seems to some extent influence adult PA, and through it, the public health of the general population (Telama et al., 2005). Thus, a PA of moderate to vigorous intensity (MVPA) for a minimum of 60 min/day among school-aged adolescents has been recommended (Adams, Caparosa, Thompson, & Norman, 2009).

Physical activity has been defined as any body movement that is produced by the skeletal muscles, which result in energy expenditure above basal levels (Ekelund et al., 2007). It is a complex behaviour, which comprises sports as well as non-sports activities. Sports are often planned, structured and repetitive, with the objective of improving or maintaining physical fitness, whereas non-sports activities can be subdivided into different categories such as occupational, leisure-time and household activities but also personal care and transportation (Plasqui & Westerterp, 2007). It is therefore important to measure it, however, due to its complex nature, it is difficult to accurately measure all of free-living PA dimensions (duration, frequency and intensity) with just one measuring tool (Plasqui & Westerterp, 2007). The doubly labeled water (DLW) technique, is considered to be the gold standard for measuring energy expenditure under free living conditions. However, this is an expensive technique, due to the high cost of the stable isotopes and the sophisticated analysis techniques it involves, therefore it is most often used in small study populations, which limits the usefulness of the DLW method in epidemiological studies (Ekelund et al., 2001; Plasqui & Westerterp, 2007).

Although the most accurate and reliable methodology for PA assessment in youth still remains to be defined, different techniques to measure PA are available, which can be grouped into five categories: a) behavioural observation, b) self-report (questionnaires and activity diaries), c) physiological markers (heart rate, body temperature, ventilation), d) motion sensors (pedometers, accelerometers) and e) indirect calorimetry (Plasqui & Westerterp, 2007). Ideally,

PA should be assessed during daily life and over periods that are long enough to be representative of the usual activity level and with minimal discomfort to the subject (Plasqui & Westerterp, 2007). Therefore, from these five categories, the most used are the self-report techniques and the accelerometers (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008). Self-report techniques are low-budget and a useful tool for assessing physical activity in large-scale or epidemiological studies, however, given that the reliability and validity of self-reported data are dependent on recall of prior activity, there may be some compromise on the accuracy of these results, thus needing validation against an objective method (i.e. accelerometry) (Rachele, McPhail, Washington, & Cuddihy, 2012). Accelerometers have a relatively moderate cost, since they are less expensive than DLW, but more expensive than questionnaires. They provide objective data on PA and are recognised as one of the most effective tools to provide objective information on young people's habitual PA (Zaragoza Casterad et al., 2012).

In terms of self-report techniques, the most used questionnaire is the International Physical Activity Questionnaire (IPAQ), which was developed by the World Health Organization (WHO) (Craig et al., 2003). However, this tool, both in its long and short versions, has shown significant but not strong correlations with accelerometry in adolescents (Craig et al., 2003) and it has been shown that it is not entirely suitable for adolescents, since many of the activities asked do not apply to their daily-life activities (Hagstromer et al., 2008).

Another self-report tool used to assess PA is the Physical Activity Index (PAI), developed by Telama et al. (1997), which is a short questionnaire with only 5 questions, designed for adolescents, easy to understand and to answer However, it has not yet been related with an objective measuring tool in Portuguese adolescents hence the need to further validate it with accelerometry.

Accelerometry is an objective tool used to assess PA. It has been validated extensively during controlled laboratory settings in various groups of subjects, as well as during free-living conditions. Data from these studies suggests a relatively high degree of validity for quantifying the intensity of PA (Ekelund et al., 2002; Trost, McIver, & Pate, 2005). Accelerometers provide a measure of the intensity and duration of body movement (i.e., the dynamic component of movement) in 1 or 3 planes (vertical, lateral, and anterior- posterior), thus being designated as uni or triaxial (Ekelund et al., 2002). Raw activity monitor data can be used to assess the relative intensity and duration of PA. In addition, accelerometers provide a valid measure of total PA

(Ekelund et al., 2002). Accelerometers have also been suggested as one of the best criterion measures for validation of self-reported instruments of physical activity (Benitez-Porres, Delgado, & Ruiz, 2013) and as the appropriate objective methodology to assess PA in adolescents of 14 years old or younger (Hagstromer et al., 2008).

Given that the PAI was designed specifically to the adolescent population, there is a need to examine whether its use in adolescents is comparable with an objective measurement, such as accelerometry. Therefore the main aim of this study was to examine how comparable the PAI and accelerometry are among Portuguese adolescents. Secondly, it was explored if adolescents follow the physical activity recommendations established for their age.

METHODS

Study design and Ethics

This study was a cross-sectional study conducted with adolescents that was part of a broader study to establish the reference values on physical condition and respiratory sounds in children and adolescents. It was approved by the Ethics Committee of the Research Unit of Health Sciences at the School of Nursing in Coimbra, Portugal (Annex I). Since participants were minors, prior to data collection, written informed consents were collected from them and from their legal representatives (Oliveira & Pereira, 2006).

Recruitment and Participants

A convenience sample of 97 adolescents between 12 and 16 years old, were approached to participate in the study. They were contacted from three basketball teams in a club in Aveiro, Portugal (Clube do Povo de Esgueira), two classes from an elementary school also in Aveiro, Portugal (Escola Básica da Gafanha da Encarnação) and one music class from an orchestra band in Ovar, Portugal. A brief explanation about the study was provided in an arranged meeting with the managers and teachers of the different institutions. All accepted to participate and provided written permission for the study to be conducted in their facilities.

Participants were included in the study if they were aged between 12 and 18 years, did not present signs and symptoms of cognitive impairment, musculoskeletal disorders (e.g., sprained ankle) or cardio-respiratory disorders that could compromise their health in terms of their ability to take part in physical activities. They were, excluded if they were not able to use the accelerometer for 7 days, and if they presented any signs or symptoms of substance abuse (e.g., drugs or alcohol).

Measures

Socio-demographic and anthropometric data were collected from the adolescents who participated in this study. Socio-demographic information included gender, date of birth and educational level. In terms of anthropometric data, their weight and height were measured to calculate the body mass index (BMI).

To further characterise the participants and to evaluate their lung function, spirometry was used, this procedure measures the rate of changing lung volumes during forced breathing manoeuvres and is invaluable as a screening test of general respiratory health (Miller et al., 2005).

Physical Activity was assessed with accelerometers ActiGraph (model - GT3XPlus, Actigraph MTI, Manufacturing Technology Inc., Pensacola, FL, USA), and the Physical Activity Index (PAI), developed by Telama et al. (1997). The accelerometer is a motion sensor used to assess PA, allowing to monitor long periods of time, such as daily life activities, with minimal discomfort to the subject (Plasqui & Westerterp, 2007). Specifically, ActiGraph has been shown to have acceptable reliability (Napolitano et al., 2010) and is the most widely used and extensively validated accelerometer for assessment of PA among children (McClain & Tudor-Locke, 2009).

The PAI has 5 questions, in which the answers can be punctuated between 1 and 4 points, having a maximum score of 22 and minimum of 5 points. The scale enables grouping people into four categories: the sedentary group (score=5); low active group (score=6-10); moderately active group (score=11-15) and vigorously active group (score≥16) in terms of their reported physical activity (Ledent et al., 1997). The reliability and internal consistency of the PAI were assessed by Mota and Esculcas (2002), using a sample of Portuguese healthy children (mean age=15.9 year-old; range between 13 and 20), in which they reported excellent values of test retest reliability (ICC=0.92 to 0.96) and a good internal consistency (α= .87). They did not, however validate it against accelerometry.

Procedure

Socio-demographic and anthropometric data were first collected to characterise the sample. Lung function was then assessed with spirometry in the sitting position, by acquiring forced expiratory volume in 1 second (FEV1) and the ratio between FEV1 and forced vital capacity (FVC) (FEV1/FVC) with a spirometer (MicroLab Micro Medical 36-ML3500-MK8, UK) following the ATS/ERS guidelines for pulmonary function testing (Miller et al., 2005).

To evaluate PA, participants had to wear an accelerometer (Actigraph) on their right hips attached to an elastic belt, for 7 days (Ottevaere et al., 2011; Trost et al., 2005). Participants were instructed to wear the accelerometer during the entire day, except when sleeping at night, in water activities and during game time (for athletes). The monitor was initialised as described by

the manufacturer and data collected in 5-second epochs. On the 7th day, participants had to fill in the PAI.

Data reduction

The raw data from the actigraph was downloaded and analysed with ActiLife 6®. For the actigraph data to be included in the analyses at least 600 min per day of registered time was required for at least 4 days. If the participants did not meet these criteria, they would be excluded from the study sample. The total amount of physical activity recorded by the actigraph was expressed as total counts per registered time (counts·min^{-1}), in 5 seconds epochs. In order to use specific cut-off points for adolescents, the Puyau, Adolph, Vohra, and Butte (2002) cut-off points were chosen, as they have been used in previous research with youth populations (Rachele et al., 2012). To identify the time spent in MVPA, the actigraph counts had to be >3200 counts.min^{-1}(Puyau et al., 2002).

The time spent in MVPA (min.day^{-1}) and the number of steps per day recorded by the accelerometer were used in the analysis.

Statistical Analysis

Participants who took part in this study were divided by gender, thus there were two groups formed, female and male. Descriptive statistics (Mean ± Standard Deviation (SD)) were applied to characterise the sample (i.e., socio-demographic, anthropometric, lung function and physical activity data). The normality of data distribution was checked with the Kolmogorov-Smirnov tests.

Independent t-tests were used to explore differences between male and female in socio-demographic, anthropometric, lung function, time spent in MVPA (min.day-^{1}), number of steps per day and PAI. Pearson correlation coefficients (rs) were calculated to explore the correlations of MVPA (min.day^{-1}) and steps per day vs. the PAI.

Analysis of the patients' ability to follow the recommendations of the PA levels, was made using the reference values established on the WHO (2010) guidelines, for the time spent in MVPA (at least 60 minutes of daily MVPA) and the values shown by Adams et al. (2009) for the steps per day (between 10,000 to 11,700 steps per day).

Chi-square ($\chi 2$) tests were used to explore differences between male and female's educational level and their ability to reach the guideline established PA levels (i.e., 60 minutes of MVPA or 10,000-11,700 steps per day).

All correlations were calculated for female and male participants.

The data were analysed using SPSS Statistics for Windows, Version 22.0 (IBM, Armonk, NY: IBM Corp.) and the level of significance considered was set at $p< 0.05$.

RESULTS

Sample characterisation

From the initial 97 participants recruited, only 52 met the inclusion criteria. After applying the data reduction criteria, 3 participants were excluded. Thus the total sample for this study was of forty nine (n=49) adolescents (n=28; 57.14% female; mean age 14.43 ±0.96 years old).

No significant differences for height, weight and BMI were found between female and male. Both groups presented normal lung function results (Miller et al., 2005). Table 1 provides a detailed participants' characterisation.

Table 1 – Participants characterisation

Characteristics	Total (n=49)	Female (n=28)	Male (n=21)	t	p-value
Age (years)	14.37 ±0.93	14.43 ±0.96	14.29 ±0.90	.529	.968
Educational level[a] n(%)					
Lower Secondary	3 (6.12%)	1 (3.57%)	2 (9.52%)		
Upper Secondary	46 (93.88%)	27 (96.43 %)	19 (90.48%)	.740[b]	.390
Height (cm)	165.57 ±7.92	162.86 ±5.06	169.19 ±9.59	-2.989	.134
Weight (Kg)	59.58 ±11.37	59.21 ±12.36	60.07 ±10.19	-.258	.508
BMI (Kg/cm^2)	21.74 ±3.79	22.31 ±4.45	20.99 ±2.59	1.210	.206
Lung Function					
$FEV_{1\ PP}$	107.70 ±12.34	106.78 ±14.05	108.61 ±10.61	.950	.350
FVC_{PP}	100.09 ±11.38	99.70 ±13.32	100.48 ±9.33	.883	.048*
FEV_1/FVC	91.80 ±5.99	92.00 ±7.04	91.61 ±4.87	3.066	.956

Data are expressed as mean± standard deviation unless otherwise indicated. P-value and t concern the difference between female and male. BMI, body mass index; FEV_{1PP}, percentage predicted of the forced expiratory volume in 1 second; FVC_{PP}, percentage predicted of the forced vital capacity.

[a] According to the International Standard Classification of Education (ISCED).

[b] Data expressed as χ^2 value.

*p<0.05

Physical activity

In terms of the PA data measured by the accelerometer, no significant differences were found between female and male participants regarding time spent in MVPA and number of steps per day. Similar results were found for the PAI.

According to the PAI activity groups, PAI results show that one participant was in the sedentary group (score=5), 3 were in the low active group (score=6-10), 10 were in the moderately active group (score=11-15) and 35 participants were in the vigorously active group (score≥16). The participants had an average score of 16, both in the overall sample and when analysed by gender. Thus, the participants were considered to be in the vigorously active group on the basis of their reported PA, with the PAI.

Table 2 shows accelerometry variables (MVPA and steps per day) and PAI descriptive data, as well as their differences.

Table 2 - Accelerometry variables and PAI descriptive data, as well as their differences

Characteristics	Total (n=49)	Female (n=28)	Male (n=21)	t	p-value
MVPA (min.day^{-1})	38.85 ±15.13	33.80 ±14.27	45.59 ±13.82	-2.899	.625
Steps per day	10177.50 ±2547.25	9527.38 ±2414.97	11044.33 ±2513.64	-2.138	.720
PAI score	16.22 ±3.55	16.32 ±3.38	16.10 ±3.85	.219	.739

Data are expressed as mean± standard deviation unless otherwise indicated. P-value and t concern the difference between female and male. MVPA, moderate to vigorous physical activity (min.day^{-1}); PAI, physical activity index.

p>0.05

Subjective vs. objective measurement of PA

When considering the female's group, objective (time spent in MVPA and number of steps per day) and subjective (PAI results) only time spent in MVPA were inversely and significantly correlated with the PAI results (r=-.389, p=.041). The number of steps per day was inversely yet not significantly correlated with the PAI results(r=-.242, p=.215). In contrast, in the male's group both objective measurements, were moderately and significantly correlated with the PAI results (r=.514, p=.017; r=.460, p=.041, respectively). MVPA and steps per day, were as expected, strongly and significantly correlated in female and male (r=.862, p<.001; r=.604, p=.005,

respectively). The correlations between the objective and subjective PA variables are shown in Table 3.

Table 3 - Pearson correlation coefficients (r_s) between the PAI and the MVPA and Steps per day

	PAI			
Actigraph variables	Female (r)	p-value	Male (r)	p-value
MVPA (min.day^{-1})	-.389	.041	.514	.017
Steps per day	-.242	.215	.460	.041

p-value concern the significant difference between female and male. MVPA, moderate to vigorous physical activity; PAI, physical activity index.

$p<0.05$

PA Guidelines vs. actual levels of PA measured with accelerometry

When exploring whether participants achieved the guideline values for PA, no significant differences were found between females and males. Considering that participants should accumulate at least 60 minutes of MVPA or 10,000 to 11,700 steps per day, only 1 female (3.57%) and 3 males (14.29%) surpassed the 60 min.day^{-1} mark and, in terms of steps per day, only 13 females (46.43%) and 13 males (61.90%) registered over 10000 steps per day. Data is presented in Table 4.

Table 4 - Number of participants that achieved the guideline values for PA

PA Guideline	Female (n=28) n (%)	Male (n=21) n (%)	χ^2	p-value
≥60 min.day^{-1}	1 (3.57%)	3 (14.29%)	1.838	.175
<60 min.day^{-1}	27 (96.43%)	18 (85.71%)		
≥ 10000 steps per day	13 (46.43%)	13 (61.90%)	1.154	.283
< 10000 steps per day	15 (53.57%)	8 (38.10%)		

Data are expressed in absolute numbers (n) and percentages (%).

$p>0.05$

DISCUSSION

The purpose of the present study was to assess how comparable the PAI and accelerometry are among Portuguese adolescents. The results showed that female and male adolescents present similar physical activity levels measured with a subjective or an objective measure. Most participants were sedentary when analysing the objective data and considering the PA recommendations (Adams et al., 2009; WHO, 2010). Correlations between objective and subjective measures were significant and positive only for male adolescents.

The fact that female and male presented similar physical activity levels differ from the majority of the literature, which states that male adolescents have higher levels of physical activity than female adolescents (Riddoch et al., 2004; Vilhjalmsson & Kristjansdottir, 2003). A large portion of the sample of this study was recruited among three basketball teams, which might have influenced the results, since female adolescents in the present study could have been more active than the female adolescent sample from other studies.

In a similar study Zaragoza Casterad et al. (2012), showed slightly different results in terms of correlation between accelerometry and the PAI. In their study, findings suggested that the PAI showed modest yet significant ($p<0.01$) validity for both male and female adolescents. However, in the present study when the female group reported lower levels of PA with the PAI, higher levels of PA were measured by accelerometry. Therefore, an inverse correlation in the female's group was found, meaning that female did not perceive/report their PA levels correctly. In the males' group the correlations were moderate and significant for both types of data, which is in line with the above mentioned study.

In a study with Portuguese population, Raia et al. (2011) reported that, when asked, adult women showed no difference regarding the number of times per week they practiced PA, when compared with men, however, they perceived themselves as more active than they really were. Although with opposite results from the present study, this may show a cultural inability of Portuguese women to perceive the real quantity of PA they practice, which should be further studied, in order to understand such differences.

Some of the variability found in the differences between male and female for the correlation between accelerometry and the PAI could be explained by the fact that the scale does not take into account activities besides sports/leisure that are either performed at school or in a sports

club, such as unplanned and free activities (i.e. transportation), which when comparing with accelerometry may create discrepancies in time spent in MVPA or steps per day (Zaragoza Casterad et al., 2012). Another aspect that could be accounted for the variability in the correlation of objective and subjective measurement tools has to do with the cut-off points used. Although the Puyau et al. (2002) cut-off points for PA intensities are one the most used for youth, there is no consensus yet on which should be the best cut-off points to be used. The use of accelerometer cut-off points to determine moderate and vigorous PA may create a measurement error, as early research has shown that the results obtained from a population vary when using different cut-off points (Guinhouya et al., 2006)

Results obtained by the accelerometer also showed that only 3.57% of female and 14.29% of male were able to surpass the 60 $min.day^{-1}$ of physical activity mark, which is the predicted value for time spent in MVPA, considering their age. Results were slightly better in terms of steps per day, when compared with the predicted values, where 46.43% female and 61.90% male achieved the guideline established values (Adams et al., 2009; WHO, 2010). These results are concordant with Nader et al. (2008) findings, where only 31% of 15 year old adolescents were above the recommended 60 $min.day^{-1}$ of MVPA, during weekdays and only 17% during weekend days.

Santos, Gomes, Ribeiro, and Mota (2005) showed that the amount of time spent in sedentary activities by Portuguese adolescents seems to be increasing, especially during the winter/cold season. These findings relate to the results of Ortega et al. (2013) and Matthews et al. (2008) who show there is a decline in MVPA (overall change = 30 min/d) and an increase in sedentary time (overall change = 2:45 h/d) observed from childhood to adolescence in Europe and United States of America, respectively. This leads us to believe Portuguese adolescents are following the same patterns of less time spent in MVPA and probably engaging in prolonged sedentary behaviours, mainly in school and in school-related activities, due to increased expectations within the schools that children must spend prolonged time on tasks as they advance through grades (Kwon, Burns, Levy, & Janz, 2012). These results are alarming considering the impact sedentary behaviours have in adolescents and in their future lives (Telama et al., 2005).

Limitations and future work

Several limitations need to be acknowledged. First, a small (n=49) and convenience sample was included in this study, which limits the generalisation of its results. Second, although the sample

age was within the adolescent ages, it was concentrated on the 14 and 15 years of age. Thus, it does not represent the whole range of ages included in adolescence, which also contributes to the impossibility of generalising the results. Third, we tried to validate the PAI for the Portuguese population, however our results showed it was not valid for female adolescents. The same might not happen in samples from other countries. Forth, for the actigraph data to be included in the analyses at least 4 days of registered time were required, however it was not made a distinction between weekdays and weekend days, as some studies mention. This should be accounted in the future, since the results might be slightly different due to the variations in PA patterns during these two periods of the week (Napolitano et al., 2010; Ortega et al., 2013).

In order to understand if the PAI is correlated with physical activity collected with accelerometry in adolescents, more studies should be performed, in which the sample size and the age span are larger, and in which weekdays are differentiated from weekend days. The participants should also be recruited from a wider variety of backgrounds, since in this study there were many athletes, which could have compromised the results. It is also necessary to further study the paediatric cut-off points, so there can be a consensus on which to use for each population.

CONCLUSION

The results show that there are no significant differences in PA levels between male and female adolescents and suggest that the PAI is able to correlate with accelerometry. However, in the present study a positive correlation only occurred for the male group, having the female not been able to correctly perceive their physical activity levels. Thus, it is necessary to further investigate the correlations between accelerometry and the PAI, with larger and more generalisable samples.

It was also seen that these adolescents do not reach the PA levels recommended for their age, which may be due to a large amount of time spent in sedentary activities nowadays. This is a matter worth further analysing since adolescents' sedentary behaviour has a great impact in their health, both in the present and in their future lives as adults.

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ANEXO I

COMISSÃO DE ÉTICA

da **Unidade Investigação em Ciências da Saúde - Enfermagem** (UICISA: E)

da **Escola Superior de Enfermagem de Coimbra** (ESEnfC)

Parecer Nº P186-10/2013

Título do Projecto: Estabelecimento de valores de referência para sons pulmonares adventícios e o teste de marcha com carga progressiva modificado em crianças saudáveis e com patologia respiratória

Identificação do Proponente

Nome(s): Alda Sofia Pires de Dias Marques; Ana Luísa Araújo Oliveira; Sara Sequeira Silva

Filiação Institucional: Escola Superior de Saúde da Universidade de Aveiro

Investigador Responsável/Orientador: Profª Alda Sofia Pires de Dias Marques

Relator: José Carlos Amado Martins

Parecer

Trata-se de estudo descritivo, correlacional, tendo como objetivo principal: "estabelecer valores de referência para os sons pulmonares adventícios e para o teste de marcha com carga progressiva em crianças com patologia respiratória e saudáveis, contribuindo assim para melhor compreensão das patologias, e consequentemente, melhorar o diagnóstico, monitorização e tratamento de crianças com problemas respiratórios".

Será utilizada amostra de conveniência, com crianças (idade<18 anos), com diagnóstico de patologia respiratória pediátrica e crianças saudáveis. Os critérios de inclusão/exclusão são definidos. Colheita de dados de dezembro de 2013 a dezembro de 2016.

A caracterização decorrerá no Hospital Santa Maria (Porto), Banda Filarmónica Ovarense (Ovar), Clube do Povo de Esgueira (Aveiro) e Clínica Estrela Esteves Unipessoal (Aveiro), instituições com as quais existe protocolo de colaboração com a Universidade de Aveiro e que já aprovaram o estudo, sendo apresentados comprovativos.

São definidas as medidas e testes a utilizar que têm um carácter não invasivo.

É garantida a confidencialidade e o anonimato da informação em todo o processo de recolha e análise. Será solicitado o consentimento do responsável legal de cada criança e à própria criança, em função do seu grau de maturidade. São apresentados os documentos para informação e obtenção do consentimento na forma escrita, que cumprem os requisitos éticos.

Não são previstos desvantagens ou riscos para os participantes.

Tendo em consideração o exposto, é entendimento desta Comissão que, em termos éticos, nada há a opor ao desenvolvimento da investigação.

O relator: José Carlos Amado Martins

Data: 20/11/2013 O Presidente da Comissão de Ética: Adriano Sousa

ANEXO II

Questionário de Actividade Física

O presente questionário pretende identificar o nível de actividade física dos jovens, por isso, são-te postas questões sobre os teus hábitos de actividade física, mas não te preocupes em acertar ou errar, porque não existem respostas certas ou erradas. Procura ser sincero nas tuas respostas e, desde já, agradeço a tua colaboração.

QUESTÃO 1: Fazes parte de actividades desportivas extra-escola (num clube ou noutro sítio)? *Faz uma cruz no quadrado correspondente*

Nunca ☐ Menos de uma vez por semana ☐ Uma vez por semana ☐ Quase todos os dias ☐

QUESTÃO 2: Participas em actividades de lazer (ocupação do tempo livre) sem integrares um clube? *Faz uma cruz no quadrado correspondente*

Nunca ☐ Menos de uma vez por semana ☐ Uma vez por semana ☐ Quase todos os dias ☐

QUESTÃO 3: Para além das horas lectivas, quantas vezes praticas desportos durante, pelo menos, vinte minutos? *Faz uma cruz no quadrado correspondente*

Nunca ☐ Pelo menos uma vez por mês ☐ Entre uma vez por mês e uma vez por semana ☐ Entre 2 a 3 vezes por semana ☐

Entre 4 a 6 vezes Por semana ☐ Todos os dias ☐

QUESTÃO 4: Fora do tempo escolar, quanto tempo por semana dedicas à prática de actividades desportivas ao ponto de ficares ofegante (respirar depressa e com dificuldade) ou transpirando? *Faz uma cruz no quadrado correspondente*

Nunca ☐ Entre meia-hora e uma hora ☐ Entre 2 a 3 horas ☐ Entre 4 a 6 horas ☐

Sete ou mais horas ☐

QUESTÃO 5: Participas em competições desportivas?
Faz uma cruz no quadrado correspondente

Nunca participei ☐ Não participo, mas já participei ☐ Sim, a nível interescolar ☐ Sim, ao nível de um clube ☐

Sim, a nível nacional e/ou internacional ☐